DINAMAP® PRO Monitor
Models 100, 200, 300, and 400

Service Manual

CRITIKON
VITAL ANSWERS™

List of Effective Pages

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U.S. Patent 4,349,034
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U.S. Patent 4,501,280
U.S. Patent 4,546,775
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SECTION 4. GENERAL MAINTENANCE

4.1. INTRODUCTION

This section contains maintenance procedures for the DINAMAP[a] PRO Series 100-400 Monitor, including description of the software screens and menus used to adjust, configure and check the Monitor. Also included are procedures to re-calibrate the NIBP, and adjust the overpressure points.

Procedures pertaining to SpO_2 and temperature functions apply only to PRO Monitors equipped with these features.

4.2. FUSES

The PRO Monitor power circuits incorporate five fuses. None of the fuses are externally accessible. Two mains fuses are mounted on the AC Mains converter board, and are not serviceable by user.

If a mains fuse blows, the monitor will not change from battery power to mains power when it is plugged in to an AC power source. To confirm a fuse problem, remove the battery, plug the unit in, and turn it on. If the PRO Monitor does not operate, the probable cause is an open fuse. Mains fuses should only be replaced by a qualified service technician.

The other three fuses are:

- FS1 - Self resetting; DC input; PSU board
- FS2 - Self resetting; Battery; PSU board
- FS3 - Self resetting; Host port power; PSU board

4.3. PERIODIC MAINTENANCE

Periodic maintenance tasks include cleaning the PRO Monitor, checking pressure calibration, pneumatic leakage, pneumatic system overpressure point, the temperature calibration (PRO Monitors 200 and 400), and verification of the SpO_2 system (PRO Monitors 300 and 400).

4.3.1 Cleaning the Monitor

The exterior of the PRO Monitor may be wiped clean with a cloth slightly dampened with mild detergents or standard hospital bactericides.

Cleaning with isopropyl alcohol or similar solvents is not recommended.

Do ***not*** immerse unit.

Do ***not*** immerse hoses.

Do ***not*** immerse cuffs without prior application of cuff hose caps.

CAUTION

Moisture or foreign substances introduced into the pneumatic system will cause damage to the unit. Calibration equipment should always be kept dry and clean.

4.3.2 Power Up Checks

When the PRO Monitor is powered up, it conducts a series of self-tests to ensure that the displays and other functions are operating normally. Some malfunctions generate fatal errors and put the Monitor in Failsafe mode. In this mode, the patient monitoring features are disabled. Other malfunctions do not interfere with normal operation, but should be repaired at the next opportunity.

As part of a periodic maintenance routine, observe the power-up self tests, and service as required.

LED Display Check

All seven segments of the LED bulbs are illuminated during the power up sequence. The segments light in a sequence beginning with the upper left segment.

LCD Display and LCD Back Light Check

Observe the LCD during power up. Confirm that all of the pixels on the LCD display are lit momentarily, and the back light is powered during initialization. The backlight is only noticeable in a dimly lit room. Confirm that the display indicates the software version in inverted format (white on black).

NIBP Calibration Check

If the NIBP system is uncalibrated, the Monitor boots directly to service mode and displays a service menu. Refer to 4.10 PRO Monitor Calibration Procedures, page 4-17.

Speaker Check

During power up, the audio system generates three short beeps, followed, after a brief pause, by three more beeps. If the speaker generates distorted, or no sound, it is faulty.

Remote Alarm Switching Check

When the PRO Monitor is off, the remote alarm switches to an alarm state. The system clears the alarm state during power up. If the remote alarm does not change states, it is faulty.

4.3.3. External DC Supply and Battery

The power indicators on the lower left on the front of the PRO Monitor show the source and charge status of the battery. The external power indicator LED continuously glows green to show the battery is charging.

The indicator flashes every four seconds to show an external power source is connected, but is not charging the battery. Either a battery is not installed or the external DC input voltage is too low.

1. Power on, and wait for the Pro Monitor to initialize. Confirm that the external power indicator is lit and the battery LED is extinguished.
2. Remove the battery and confirm that External DC LED on Monitor flashes.
3. Fit the battery and disconnect the external power supply. Confirm the external power indicator extinguishes, the battery LED glows yellow, and the battery icon appears on the LCD, toggling with the time indicator. If the battery power is low, the battery LED flashes every four seconds, and the battery icon on the LCD changes.
4. Reconnect the external power supply, verify that the battery LED extinguishes.

4.3.4. Care Of The Storage Battery

It is best to keep the battery charged as fully as practical. Never store the Monitor with the battery in a discharged condition. When the battery no longer holds a charge, remove and replace with one of the same part number.

PRECAUTIONS

To ensure that the battery is ready for portable operation, keep the unit connected to AC mains whenever possible. Repeated failure to fully charge the battery significantly reduces battery life. Avoid storing batteries at temperatures above 77° F (25° C). High storage temperatures can dramatically increase the self-discharge rate of battery.

4.3.5. Checking NIBP Calibration

Perform the test procedures described in 4.8, page 4-15 every 12 months, or whenever the accuracy of any of the parameters is in doubt.

4.4 SERVICE MODES AND MENUS

The PRO Monitor operates in three service modes, each allowing different levels of access to the Monitor functions, set up, and calibration. These modes are accessed from the **More...** option on the Main menu, and require a code before a user can access them.

The **Clinician Mode** enables the user to:

- Toggle between Celsius and Fahrenheit
- Verify NIBP calibration dates
- Change the alarms to "Permanent Silence" mode.

This section provides an overview of the Clinician menus. For more information and details of operation, see the *PRO Monitor Operation Manual.*

The **Service Mode** provides the features allowed from the Clinician menu, and adds these functions:

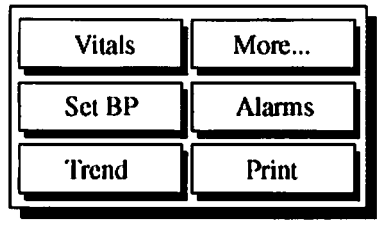
- Check the NIBP calibration
- Re-calibrate NIBP
- Adjust the pneumatic system overpressure point
- Configure communications with a host computer
- Change the language of operation

The **Super Service Mode,** or diagnostics mode, allows the technician to perform more advanced tests on the pneumatic system. The other menu options within this mode are for hardware tests and diagnostics purposes. For information reagarding the other options in Super Service mode, contact Critikon Technical Support at 877-CRITIKON.

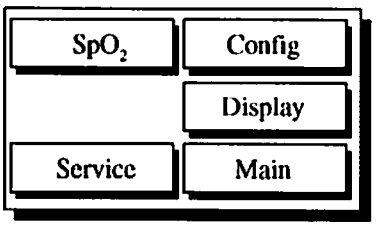
4.4.1 Accessing the Service Menus

To enter a service menu from the Main Menu, use the rotor control and LCD.

1. Select the **More...** button



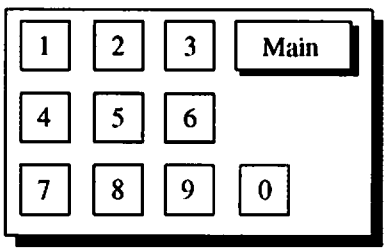
2. Select the **Service** button



3. Enter the access code on the numeric screen.

The service menus require a four-digit access code. Rotate the select knob to highlight a number, and push to make a selection.

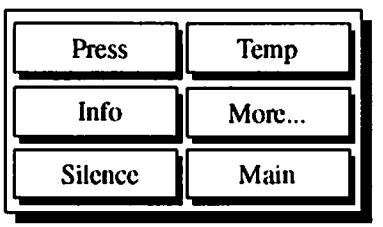
The access codes:



1 2 3 4 To access the Clinician Menus
2 2 1 3 To access the Service Menus
8 3 7 8 To access the Super Service Menus

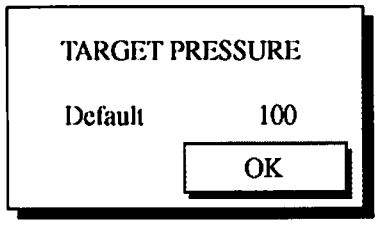
4.5 CLINICIAN MODE AND MENUS

4.5.1 Clinician Mode Main Menu



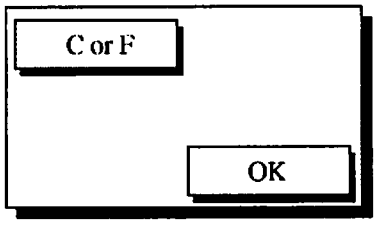
The Clinician Mode Main menu, pictured above, provides access to the options normally required for routine use of the PRO Monitor. The individual buttons on this menu are described briefly below.

Press Button



Selecting the **Press** button displays the target pressure dialog box, pictured above, which sets the default target inflation pressure for an NIBP cycle. The factory default is 160 mmHg for adults and 110 mmHg for neonates. This is indicated by the "AUTO" label at either end of the adjustable range.

Temp Button

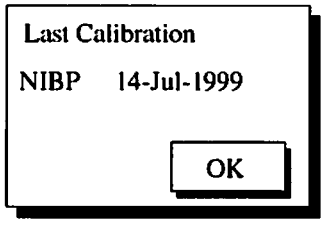


Selecting the **Temp** button displays the dialog box which toggles the temperature units of the Monitor between Celsius and Fahrenheit. When Celsius is selected, the °C indicator lights. When Fahrenheit is selected, the °F indicator lights. Click on **OK** to save the selection.

CAUTION

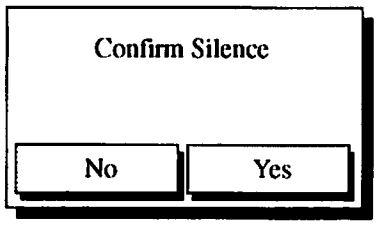
Changing temperature units will clear the trend readings. Before the readings are cleared, a dialog box requests the user confirm or cancel the change.

Info Button



Selecting the **Info** button displays the most recent calibration dates of the NIBP. Click **OK** to return to the Service menu.

Silence Button



Selecting the **Silence** button displays the dialog box, pictured above, which mutes **all** the alarms except the failsafe alarm. The alarms are disabled until the Monitor is either powered off and on again, or the Alarm Silence button is pressed. Either **Yes** or **No** will exit the menu. If silence is confirmed, the Alarm Silence button illuminates.

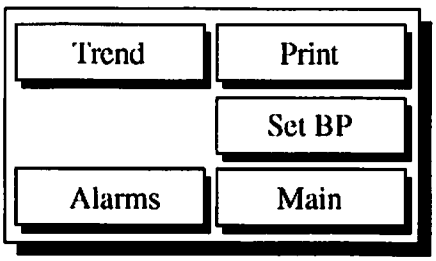
More ... Menu Button

The Clinician *More...* menu accesses controls which allows the user to permanently change the default settings.

Main Button

Select this button to exit the service menu and return to the Main Menu.

4.5.2 Clinician More... Menu



The Clinician More... menu, pictured above, accesses the software controls to change the default settings of several PRO Monitor functions. These options are summarized below.

Trend Button

Displays a dialog box to automatically clear trend data on power up. The default setting is **Yes**. In the default setting, trend data is cleared when the PRO Monitor is shut off. Select **No** to retain the trend data on power-down.

Print Button

Displays a dialog box to restore the print mode on power up to user-selected print mode (auto or manual) or the default print mode. The print mode can be selected through the print

button on the Main menu. The current mode is displayed in the lower right corner on the LCD. Select **No** and the PRO Monitor powers up in manual print mode. Select **Yes**, and the monitor retains the user-selected mode.

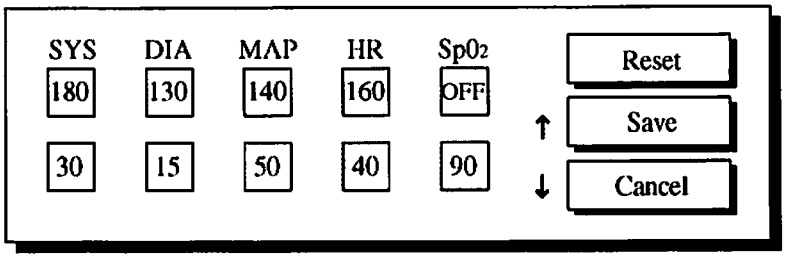
Set BP Button

Displays a dialog box to power up in a user-selected BP mode (auto/ manual). Select **Yes** to preserve the user-selected BP mode. Select **No** to power up the PRO Monitor in manual mode.

Alarms Button

This button accesses a dialog box to enter the alarms configuration menu. Selecting **Yes** enters the menu. Selecting **No** returns the user to the *More...* menu.

4.5.3 Alarms Configuration Menu



Select **Reset** to return all the alarm limits to the default settings. The illustration above shows the default settings.

The user can adjust these alarm points within the high and low limits specified in the table below, subject to the following conditions.

- The high limit cannot equal the low limit
- The high limit cannot be less than the low limit.
- The low limit cannot be greater than the high limit.
- The high and low limits are not permitted to be within a step size (see table - next page) of each other.

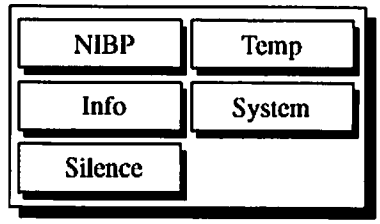
Parameter	Range	Default
Systolic High	35 - 245	180
Systolic Low	30 - 240	30
Diastolic High	15 - 195	130
Diastolic Low	10 - 190	15
MAP High	20 - 215	140
MAP Low	15 - 210	50
Heart Rate High	35 - 250	160
Heart Rate Low	30 - 245	40
SpO_2 High	51 - 100	Off
SpO_2 Low	50 - 99	90

Note: Predictive temperature has no alarm limit alarm.

Select **Save** to save the displayed settings and return to the *More...* menu. Select **Cancel** to abandon any changes and return to the *More...* menu.

4.6 SERVICE MODE AND MENUS

4.6.1 Service Mode Main Menu

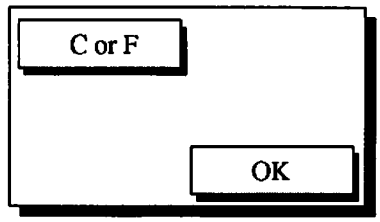


The controls accessed through the Main Service menu; pictured above, allow the technician to check basic functions of the PRO Monitor, calibrate the NIBP system, and set the language of operation. These menus and adjustments should be used only by qualified service technicians.

NIBP Button

The NIBP button accesses the NIBP Service menu. Use this menu to calibrate and check the NIBP transducers and the overpressure circuitry.

Temp Button



The **Temp** button on the Main Service menu accesses a

dialog box, pictured above, which toggles the temperature measurement units between Celsius and Fahrenheit. If the unit of measurement is changed, a warning appears to inform the user that this change clears trend information from memory. **OK** returns the display to the Main Service menu.

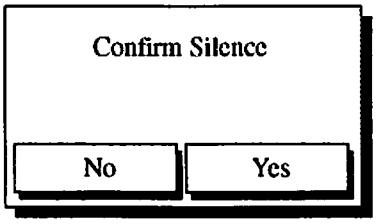
Info Button

This button displays the date of the most recent NIBP calibration. Select **OK** to return the display to the Service menu.

System Button

This button accesses the system service menu. The controls on this menu set the display language, communications protocols, test the EEPROM, and print the error log.

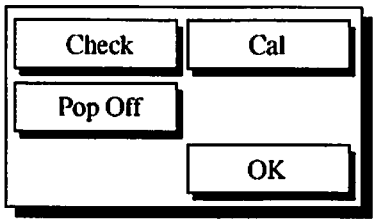
Silence Button



Selecting the **Silence** button displays a request to confirm the choice. This is a working option available only through the Clinician Mode (1234.) Alarms are disabled when in Service Mode.

Yes mutes **all** patient alarms until the PRO Monitor is powered off and on again, or the Alarm Silence button is selected again to enable the alarms. A confirmation menu appears (pictured above) on the display. Selecting either **Yes** or **No** exits the menu. If silence is confirmed, the Alarm Silence button on the front panel illuminates momentarily.

4.6.2 NIBP Menu



The options on the NIBP menu, pictured above, are used to calibrate and test BP functions of the PRO Monitor.

Check Button

This button allows the NIBP calibration to be checked. In this mode, the PRO Monitor functions as a digital manometer. The systolic LED displays the output of PT1, and the diastolic LED displays the output of PT2. The overpressure point is set to the adult value.

With no hose attached the systolic and diastolic displays will indicate "000." See 4.10, page 4-17 for a more detailed description of this mode and the calibration procedure.

Cal Button

This button initiates the calibration procedure. See 4.10, page 4-17 for a step-by-step description of this procedure.

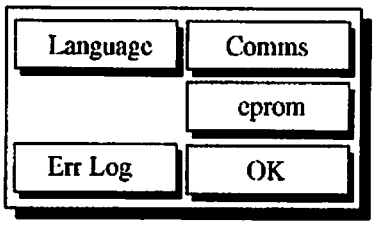
Pop Off Button

This button functions in a similar manner to the **Check** button, but the overpressure point is set to the neonate value. See 4.12, page 4-20 for a more detailed description of using this function.

OK Button

This button returns the display to the Main Service menu.

4.6.3 System Menu



The System Menu, pictured above, accesses the software controls which modify the basic configuration of the PRO Monitor, test the EEPROM, and print the error log.

Language Button

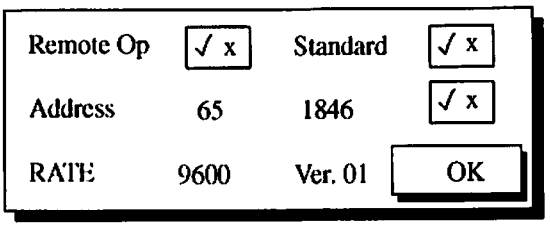
This button displays the language choices. The language dialog boxes are not pictured. The PRO Monitor software can display menus in eight languages: UK, USA, German, French, Spanish, Italian, Portuguese, and Dutch.

Selecting any language button removes all other language buttons from the screen, indicating that the remaining button is the chosen language. Selecting **Clear** restores all the language buttons, allowing the user to select again. **OK** saves the selection and requests that the monitor be turned off. If no language is selected when **OK** is pressed, the language is stored as undefined. In this case, the Monitor prompts the user to select a language on every power up until a selection occurs.

Comms Button

This button accesses the Communications menu. The settings on this menu configure communications with a host computer when PRO Monitors are connected to a network.

Comms Menu



The **Remote Op.** check box toggles remote operation. When on, a check mark (Ö) appears in the box, the PRO Monitor responds to external commands, and can initiate an NIBP determination when prompted by a host computer. Remote operation requires DINAMAP® Host Communications Protocol, which is described in the DINAMAP® *Host Communications Reference Manual.*

The **Standard** check box sets the host comms protocol to standard format, and the baud rate at 9600 bps.

The **Address** box sets the Monitor address within a range of 32 to 126. Address 32 is not unique. All monitors, regardless of unit address, respond to commands to unit address 32.

Selecting the **1846** button sets the comms protocol to 1846 format, and the baud rate to 600 bps.

The baud **Rate** can be set to 300, 600, 1200, 2400, 4800, 9600, or 19200.

Select **OK** to return to the Main Service menu.

eprom Button (EEPROM Testing)

This button initiates a test of the read and write functions on the EEPROM. The test is repeated 20 times. The results are displayed on the LCD and recorded in the error log.

Err Log Button

This button generates a printout of the last 20 system errors that have occurred on the unit. The system and secondary processor software versions are also listed on the error log.

4.7 SUPER SERVICE MODE AND MENUS

The Super Service menu is used to conduct hardware tests and diagnostic routines. The applicable hardware tests are listed in 4.13, page 4-21.

4.8 PRO MONITOR CALIBRATION PROCEDURES

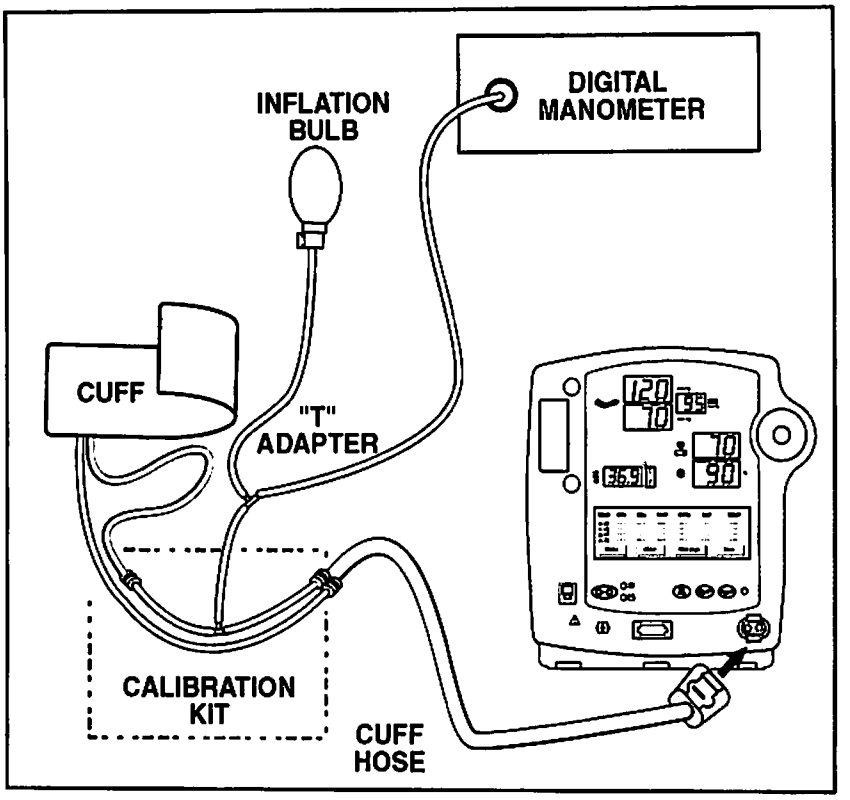


Figure 4-1. Calibration Check Set Up

Calibration procedures include verification of the NIBP calibration, calibration of the pneumatic system, and verification and adjustment of neonatal and adult overpressure points. These tests require a manometer and a pump attched to the PRO Monitor as shown in Figure 4-1, above. An adult blood pressure cuff wrapped around a semi-rigid cylinder may be used.

4.9 NIBP CALIBRATION CHECK

The BP calibration of the PRO Monitor should be checked every 12 months or whenever the validity of the NIBP readings is in doubt. Use a CRITIKON calibration kit (Part #320246) or equivalent equipment. Verifying the accuracy of the NIBP parameter does not require disassembly of the PRO Monitor.

Equipment Required

- NIST Calibrated Digital One-Tube Manometer calibrated to ±.5mm Hg
- Bulb pump or syringe
- Calibration Kit (P/N 320246)

Set Up the Test

1. Attach the calibration equipment as shown in Figure 4-1.
2. Power on the PRO Monitor and allow 10 seconds to initialize.
3. Verify that the calibration pressure measurement system reads 0 mmHg (0 mb).

NOTE

The PRO Monitor may display the language choice menu along with instructions to turn the monitor off. If this error occurs, choose the desired language and **OK**. Reboot the system by turning PRO Monitor off and back on.

---

4. Select the **More...** button from the Main menu
5. Select the **Service** button.
6. Enter the Service mode access code **2 2 1 3** to access the service menus.
7. Select **NIBP** from the service menu.
8. Select **Check** from the NIBP service menu.

   In this mode, the PRO Monitor displays pressures on the systolic and diastolic displays. Apply pressure to the system with the pump, and verify that the digital displays on the monitor agree with the readings on the manometer, with a specified tolerance of ±3 mmHg, plus tolerance of the manometer.

Upper and Lower Pressure Ranges		
Display	**Description**	**System Range**
Systolic	Pressure measured at PT1 (main pressure transducer, on main board)	0 mmHg - 300 mmHg
Diastolic	Pressure measured at PT2 (on pump assembly)	0 mmHg- 330 mmHg

Overpressure occurs before 330 mmHg. Pressure can not be measured above the overpressure set point.

Normal operation is not possible until the PRO Monitor is powered off and back on.

4.10 CALIBRATING THE NIBP SYSTEM

The following procedure describes the steps required to calibrate the PRO Monitor. Disassembly is not required.

4.10.1 The NIBP Calibration Procedure

1. Set up the Monitor and calibration equipment as shown in Figure 4-1.
2. Power on the PRO Monitor.
3. Verify that calibration equipment reads 0 mmHg (0 mb) of pressure.

NOTE

If the PRO Monitor displays the language choice menu, select a language. Select **OK** and reboot the system.

---

4. Select the **More...** button from the Main menu.
5. Select the **Service** button.
6. Enter the Service Mode access code **2 2 1 3**.
7. Select the **NIBP** button from the Service menu.

IMPORTANT

From this point, the timing is critical. Before proceeding, review the following steps.

Setting the Calibration Points

1. Select **Cal** from the NIBP menu.
2. The Monitor displays Set Pressure to 0 mmHg.
3. Ensure calibration test equipment is at 0 mmHg.
4. Press **Accept** to continue or **Cancel** to quit this procedure.
5. The Monitor displays Set Pressure to 200 mmHg.
6. Apply the pressure (200 mmHg) and HOLD the pressure. Press **Accept** to continue or **Cancel** to quit this procedure.
7. If Accept is chosen, the monitor will vent the system to atmosphere. Immediately prior to venting, the monitor stores the set pressure reading into system memory.

The zero reading and the 200 mmHg reading are the only points used for calibration. It is important to ensure that the correct pressures are applied at these two points.

After venting, the Monitor displays "**Calibration Complete**" or "**Calibration Failed.**"

If the calibration fails, turn off the Monitor, check the calibration equipment and repeat the process. Refer to a CRITIKON service representative if calibration is still unsuccessful. When the calibration is successful, the PRO Monitor enters a "Failsafe Alarm" mode (audible solid tone). The PRO Monitor is accurately calibrated and can be switched off.

Check the calibration of unit by repeating procedure in 4.9, page 4-16.

4.11 NEONATE/ ADULT OVERPRESSURE CHECKS

The following procedures describe how to verify the pressure at which the Monitor over-pressure detection system prevents further cuff inflation and generates an alarm.

Set up the test

1. Attach the calibration equipment as shown in Figure 4-1.
2. Power on the PRO Monitor.

Verify that calibration equipment is at 0 mmHg (0 mb) of pressure.

4.11.1 Neonate Overpressure Check

1. Select the **More...** button from the Main menu.
2. Select the **Service** button.
3. Enter code **2 2 1 3** to access the service menu.
4. Select the **NIBP** button from the Service menu.
5. Select the **Pop Off** button from the NIBP menu.
6. Apply pressure to the NIBP system with the bulb, pump, or syringe.

NOTE

If the PRO Monitor displays the language choice menu, select a language. Select **OK** and reboot the system.

Observe the pressure at which the dump valve opens and count the time required for the pressure to fall to less than 20 mmHg.

Verify that the maximum pressure, as shown on the calibration equipment, is within the range of 150 mmHg - 165 mmHg at overpressure and the system pressure falls to less than 20 mmHg within 4 seconds.

CAUTION

For the adult overpressure check, ensure that the calibration pressure measurement system is capable of displaying pressures up to 350 mmHg safely.

4.11.2 Adult Overpressure Check

1. Attach the test equipment and power up the PRO Monitor in similar manner as the previous tests.
2. Select the **More...** button from the Main menu.
3. Select the **Service** button.
4. Enter code **2 2 1 3** to access the Service menu.
5. Select the **NIBP** button from the service menu.
6. Select the **Check** button from the NIBP service menu.
7. Apply pressure to the NIBP system with either a bulb, a pump, or a syringe.

Observe the pressure at which the dump valve opens and count the time required for the pressure to fall to less than 20 mmHg.

Verify that the maximum pressure, as shown on the calibration equipment, is within the range of 300 mmHg - 330 mmHg at overpressure and the system pressure falls to less than 20 mmHg within 8 seconds.

4.12 OVERPRESSURE ADJUSTMENT

This procedure describes how to set the overpressure setting – the pressure at which the Monitor automatically opens the valves and stops the pump. Only the neonatal can be set, as monitor doubles the user-defined neonatal setting to set the adult overpressure setting.

Adjusting the overpressure is **only** possible by opening the PRO and adjusting the overpressure pot. on the Main board.

Equipment Setup

1. Open the case and access the Main board, as described in Section 5 of the PRO Monitor service manual.
2. Locate the overpressure adjustment potentiometer (VR1) at the upper right of the Main board. The adjustment is secured with adhesive applied during manufacturing.
3. Set up the PRO Monitor and calibration equipment as shown in Figure 4-1.
4. Power on the PRO Monitor.
5. Verify that the calibration pressure measurement system reads 0 mmHg (0 mb).

NOTE

If the PRO Monitor displays the language choice menu, select a language. Select **OK** and reboot the system.

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6. From the Main Menu, select the **More...** button.
7. Select the **Service** button from the More... menu.
8. Enter access code **2 2 1 3** to display the service menu.
9. Select the **NIBP** button from the Service menu.
10. Select the **Pop Off** button from the NIBP menu. This button sets the overpressure point to the neonate value.
11. Apply pressure to the system with the bulb, pump, or syringe until the valve opens and releases the pressure.

The point when the valve opens should be 157 +/-1 mmHg. If the overpressure point is too low, turn the potentiometer

clockwise to raise the overpressure. If the point is too high, turn the potentiometer *counterclockwise* to lower the point. Repeat the procedure until the overpressure is within the limits specified above. Re-secure the adjustment with adhesive. The adult overpressure point is double the neonate value.

4.13 PRE-SERVICE TEST PROCEDURES

The following procedures can be used to check the primary functions of the PRO Monitor before releasing the unit for clinical service.

The Monitor is tested by applying various stimuli to the sensor interfaces or measuring of specific parameters. The test procedures employ features of the operational software and the test modes of the Service Menus.

A guide to the PRO Monitor controls, indicators and connectors is in Section 2 of the PRO Monitor service manual.

Test Equipment

1. Digital Pressure Gauge 0-375mmHg, 0.2% accuracy, Digitron P200L or similar.
2. NELLCOR* SpO_2 Simulator Model SRC-2, PT2500 or N1290 or similar.
3. NIBP Calibration Kit CRITIKON P/N 320246, or similar.
4. IVAC** Probe Simulator, P/N 193737, Alaris Medical Systems.

Test Conditions

Testing shall be conducted with an ambient temperature of 25 °C ± 5 °C (77 °F ± 9 °F).

Service Modes

During several procedures the operator needs to enter the Service mode or the Super Service mode. The Monitor can be switched into these modes by using the following procedures.

Selecting Service Mode

1. From the Main menu select the **More...** button.
2. From the sub menu select the **Service** button.
3. Enter access code **2 2 1 3** to display the Service menu.

* NELLCOR is a trademark of Mallinkrodt, Inc.

** IVAC is a trademark of Allaris Medical Systems.

Selecting Super Service Mode

1. From the Main menu select the **More...** button.
2. From the sub menu select the **Service** button.
3. Enter the access code **8 3 7 8** to display the Super Service menu.

4.13.1 SpO_2 Checks (PRO 300 & 400)

These procedures apply only to the PRO 300 & 400. The SpO_2 parameter should be tested once a year at the minimum and whenever the SpO_2 appears to be out of tolerance.

Pulse Data and Saturation Data Verification

1. Connect a NELLCOR pulse simulator (model SRC-2, PT-2500 or N-1290) to simulate an SpO_2 sensor.
2. Power on the PRO Monitor.
3. From the Main Menu, select the **Alarms** button.
4. Set the BPM upper limit to 250.
5. Set BPM lower limit to 10.
6. Set SpO_2 upper limit to OFF.
7. Set SpO_2 lower limit to 50.
8. If using a NELLCOR N-1290 simulator, connect the simulator cabling to the PRO and power it on.
9. Test the PRO Monitor using the full range of saturation and pulse rate settings available on the simulator. Confirm that the unit readings are within the tolerances defined below.

Pulse Search Verification

Set the pulse rate to zero on the NELLCOR simulator. Verify the "No SpO_2 Signal" message is displayed on the PRO Monitor LCD. Acknowledge the message by pressing rotor switch.

Probe Disconnected Verification

1. After a period of normal operation with a heart rate of 90 applied, remove the SpO_2 sensor from the simulator, verifying that a "No SpO_2 Signal" message is displayed on the Main LCD.
2. Acknowledge message by pressing the rotor switch.
3. Remove the SpO^2 sensor from the PRO, verify that "No SpO_2 Sensor" message is displayed
4. Acknowledge message by pressing the rotor switch.
5. Power down the PRO Monitor.

4.13.2 NIBP Calibration Check

This procedure verifies the linearity and calibration for both pressure transducers (PT1 and PT2) across the range from 0 (-0 to +3) mmHg to 250 (± 3) mmHg.

1. Set up the unit and calibration equipment as shown in Figure 4-1.
2. Power on the PRO Monitor and select **More...**
3. Select the Service mode and input **2 2 1 3**.
4. From the Service menu, select the **NIBP** button.
5. From the NIBP menu, select the **Check** button.
6. Apply the following pressures (measured by an external digital manometer) and confirm that the Monitor readings agree with the following table for both PT1 and PT2 channels.

PT1 & PT2 Linearity Check

Applied Pressure mmHg	Measured Pressure mmHg (at Monitor)
0	0 -0 to +3
50	50 ±3
100	100 ±3
150	150 ±3
200	200 ±3
250	250 ±3

If calibration is required, refer to 4.10.1, "Calibrating the NIBP," page 4-17.

Neonate Overpressure Check

1. Set up the unit and calibration equipment as shown in Figure 4-1.
2. Power on the PRO Monitor and select **More...**
3. Select the Service mode and input **2 2 1 3**.
4. From the Service menu, select the **NIBP** button.
5. Increase applied pressure until over pressure occurs. Confirm that pressure at that point is between 150 mmHg to 165 mmHg, and system pressure falls to less than 20 mmHg within 4 seconds.
6. Power down the PRO Monitor.
7. If the overpressure point is out of range, adjust the overpres-

sure potentiometer as described in 4.12, page 4-20.

Adult Overpressure Check

1. Set up the unit and calibration equipment as shown in Figure 4-1.
2. Power on the PRO Monitor and select **More...**
3. Select the Service mode and input **2 2 1 3**.
4. From the Service menu, select the **NIBP** button.
5. Select the **Check** button.
6. Increase applied pressure until overpressure occurs. Confirm that pressure at the overpressure is between 300 mmHg and 330 mmHg, and the system pressure falls to less than 20 mmHg within 8 seconds.
7. Switch off the PRO Monitor and disconnect the calibration kit.
8. If the Monitor fails this test, re-calibrate the unit as described in section 4.12, page 4-20.

4.13.3 Temperature System Check (PRO 200 & 400)

The PRO Monitor Series 200 & 400 predictive temperature systems use ALARIS Model 2080 temperature probes with IVAC technology. This system is self-calibrating. The only maintenance required is to verify that the temperature functions are working properly. These checks require an IVAC probe simulator (P/N 193737), available from ALARIS Medical Systems, Inc., San Diego, CA. Critikon does not stock this tester.

To check the temperature system, connect the IVAC probe simulator to the temperature probe connector on the front panel, and insert a temperature probe into the active holster.

1. Power on the PRO Monitor.
2. Remove the temperature probe from the probe holster to initiate a temperature reading.

Set the probe simulator to 80.2 and verify that the LCD temperature display reads 80.2°F ±1.0°F. The numbers on the temperature LED displays should be flashing at this point, indicating the monitor is in a real-time monitor mode.

A range of temperatures can be checked, by using the other values on the probe simulator (98.0, 98.6, 102.0, and 107.8).

Broken Probe Sensing

Set up the equipment and the probe simulator as in the previous procedure. Rotate the temperature selector to B.P. verify that the

Temperature display reads 106.0F° ±0.2°F. Next. press BROKEN PROBE on the simulator, verify that the LED display on the monitor changes to four dashes, indicating a fault condition.

If the PRO Monitor temperature system does not pass these tests, the Main PWA needs to be replaced.

4.13.4 Overpressure Threshold Measurement

1. Set up the unit and calibration equipment as shown in Figure 4-1.
2. Power on the PRO Monitor and select **More...**
3. Select the Service mode and input **8 3 7 8**.
4. From the Super Sertvice Menu, select the NIBP button,
5. From the NIBP menu, select the ThRef Buton
6. This function measures the adult and neonatal overpressure threshold levels and reports them on the Main LCD as ADUs.

4.13.5 Leak Test

This test performs a leak test of the pneumatic system.

1. Set up the unit and calibration equipment as shown in Figure 4-1.
2. Power on the PRO Monitor and select **More...**
3. Select the Service mode and input **8 3 7 8**.
4. From the Super Sertvice Menu, select the NIBP button,
5. From the NIBP menu, select the **Leak** Buton

The leak-test sequence closes both valves and turns the pump on. The PRO monitor will self-pressurize the pneumatic test setup to approximately 200 mmHg. After 5 seconds, the target pressure value will be displayed in mmHg on the LCD. The system holds the pressure for approximately 36 seconds and continues to display the current pressure on the LCD. Confirm that the pressure has fallen no more than 5 mmHg.

4.13.6 Printer Test

This test generates a sample printout from the printer. If no paper is in the printer, the Monitor generates no alarm.

1. Power on the PRO Monitor and select **More...**
2. Select the Service button and input **8 3 7 8**.
3. From the Super Sertvice Menu, select the **Print** button,

Ensure the printed test page is clear and easy to read.

4.14 ELECTRICAL SYSTEM SAFETY CHECKS

The PRO Monitor is designed to protect the patient from exposure to harmful levels of electricity. To ensure the integrity of these safeguards, use a safety analyzer and feed 253 vac into the system. A current-leakage test must be performed on every unit whenever the case is opened for repairs, and before it is returned to clinical service. If the reading exceeds the maximum tolerance as specified below, do not return the unit to clinical service.

Normal Polarity

At normal polarity, test open ground and open neutral. The leakage reading should be <500uA.

Reverse Polarity

At reverse polarity, test open ground and open neutral. The leakage reading should be <500uA.

Temperature System Leakage (PRO 200 & 400)

Use a temperature plug with the leads shorted and apply test voltage to the leads. The leakage reading should be <50uA.

SpO_2 System Leakage (PRO 300 & 400)

Use an SpO_2 plug with the leads shorted together. The leakage reading should be <150uA.

Perform these four checks when repairs are completed, and prior to returning the monitor to clinical service.

4.15 TROUBLESHOOTING

Trouble	Probable Causes	Fault Isolation
Monitor will not switch on when powered by battery	Battery may be discharged PSU board fault	Measure terminal voltage of the battery Swap PSU board
Unit will not switch on from either battery or External AC source	On/Off switch/rotor faulty +5Vdc supply low	Try turning on by pressing the rotor switch. If monitor switches on, check On/Off signal from switch to the Main board. Measure +5Vdc supply on PSU
Pressing rotor switch fails to power on the unit, menu selection is possible	Rotor on/off switch assy	Replace rotor switch assy
No rotor repsonse	Rotor failure Main board failure	Swap rotor assy Swap Main board
When rotor is turned, menus are skipped	Rotor failure Main board failure	Swap rotor assy Swap Main board
Incorrect, illegible, or no LCD output	LCD fault Main board fault (usually accompanied by an audible alarm if Main board processor has ceased operation) Negative supply to LCD (-9.6 Vdc) is out of tolerance	Swap LCD Swap Main board Check negative supply reaching the LCD module
No LCD backlight	LCD faulty Main board fault	Swap the LCD Swap the Main board
Incorrect, missing segments,or no LED display output	Main board fault (usually accompanied by an audible alarm if Main board processor has ceased operation) No or Low +4 Vdc LED supply	Swap Main board Swap PSU board Check supply continuity from PSU board to Main board

Trouble	Probable Causes	Fault Isolation
"SpO_2 probe disconnected" error displayed on LCD	Faulty finger probe/extender cable Faulty internal SpO_2 internal cabling Faulty SpO_2 PWA	Test parameter with known good accessories Swap or test internal cabling Swap PWA and test unit with NELLCOR SpO_2 simulator
Following the monitor power-up sequence, a failsafe alarm sounds, and one of the following messages appears on the LCD: System error, P105 System error, P110 System error, P115	Faulty SpO_2 PWA Isolated power supply module failure on Main board Main board processor SpO_2 RS-232 comms failure	Swap SpO_2 PWA and reinspect the monitor Verify +5Vdc isolated power supply is within specification Swap Main board and reinspect the monitor
Overpressure warnings displayed on LCD when NIBP is initialized (with or without a cuff and hose)	Kinked air hose or faulty cuff Partial or full blockage of internal pneumatic hosing	Inspect cuff and hose for blockages Inspect the pneumatic assy for a blocked output Swap the pneumatic assy
At NIBP start, the pump sounds labored, generally accompanied by one of the following messages: N33-NIBP: Inflation Timeout N00-NIBP: Overpressure	Kinked air hose or faulty cuff Blocked or kinked hose from pump output to the front panel Pneumatic assembly failure	Test with known good accessories Examine hosing for kinks or blockages Inspect pneumatic assy for blocked output Swap pneumatic assy
TSH_HW:PIC displayed on the Main LCD	Monitor has failed temperature self-calibration.	Swap Main board.
Pump Over Current 0, (code line failure),0,0	A pump over-current condition has been signaled to the Main board processor Pump current sensing circuitry failure on the Mian board Pump failure	Swap the Main board Swap pump assy
Unit does not respond to host communications	PSU board unresponsive	Swap PSU board Check continuity of PSU board to the host comm port cable on the rear panel

Alarm Code	LED Display	LCD Description	Audible Tone and Volume	Effect of Alarm Silence Switch	Effect of Clear Via *Select-* Knob	Probable Cause
N99	Values zeroed. Dashes in NIBP windows.	N99- NIBP FAILED	High priority alarm. Volume adjustable.	2 minute silence	Clear	Unable to register NIBP measurement due to an insufficient signal.
N55	Values zeroed. Dashes in NIBP windows.	N55- TIMEOUT: PRESSURE	High priority alarm. Volume adjustable.	2 minute silence	Clear	One cuff pressure >1 minute. Motion arifact.
N44	Values zeroed. Dashes in NIBP windows.	N44- TIMEOUT: TOTAL	High priority alarm. Volume adjustable.	2 minute silence	Clear	Determination time >2 minutes. Motion Artifact.
N33	Values zeroed. Dashes in NIBP windows.	N33- TIMEOUT: INFLATION	High priority alarm. Volume adjustable.	2 minute silence	Clear	Inflation time >40 seconds or air leak detected.
N00	Values zeroed. Dashes in NIBP windows.	N00- OVERPRESSURE	High priority alarm. Volume adjustable.	2 minute silence	Clear	Overpressure state detected.
No Code	No change	LOW BATTERY- with flashing battery icon.	3 beeps every 10 seconds. Volume adjustable	2 minute silence	No effect	Replace/ recharge the battery. From onset of alarm, 5 NIBP readings available. Beep rate increases as the battery discharges.
No Code	Blank	LOW BATTERY- SYSTEM DISABLED	Steady tone. System is disabled.	No effect	No effect	Replace/ recharge the battery. Monitoring halted.
No Code	No change	PRINTER- NO PAPER	High priority alarm. Volum adjustable.	2 minute silence	Clear	Replace paper or close printer door
No Code	Values posted	NIBP RANGE ERROR	High priority alarm. Volume adjustable.	2 minute silence	Clear	NIBP algorithm value outside target range.
Other: N, P, E, I, S	Blank	Error Code, with Description	Steady tone, Maximum volume	No effect	No effect	Internal system fault.

Alarm Code	LED Display	LCD Description	Audible Tone and Volume	Effect of Alarm Silence Switch	Effect of Clear Via *Select*K-nob	Probable Cause
P55	Values zeroed. Dashes in SpO_2 window.	P55 - SpO_2 NO SIGNAL	High priority alarm. Volume adjustable.	2 minute silence	Clear	No or very weak SpO_2 signal. Check or reposition sensor.
P00	Values zeroed. Dashes in SpO_2 window.	P00- NO SpO_2 SENSOR	High priority alarm. Volume adjustable.	2 minute silence	Clear	SpO_2 sensor not connected. No sensor detected. Sensor failure.
No Code	No change	SpO_2 PLACEMENT?	High priority alarm. Volume adjustable.	2 minute silence	Clear	SpO_2 signal weak or noisy. Sensor failure.
No Code	Values zeroed	SpO_2 CABLE?	High priority alarm. Volume adjustable.	2 minute silence	Clear	SpO_2 sensor or cable possibly defective. Cable not connected properly.
E33	Dashes in Temp windows.	E33 - TEMP: FAIL	High priority alarm. Volume adjustable.	2 minute silence	Clear	Temperature probe not connected or inoperable
E00	Dashes in NIBP windows.	E00 - TEMP: FAIL	High priority alarm. Volume adjustable.	2 minute silence	Clear	Predictive temperature determination > 60 secs or attempting axillary temp
No Code	Blank	HIGH TEMP	High priority alarm. Volume adjustable.	2 minute silence	Clear	Predictive temperature reading exceeds upper range limits